



The **Mars Electrostatics Chamber** has an external length of 2 m, external diameter of 1.3 m, and interior volume of 1.5 m³. The chamber houses an experiment deck measuring 1.43 by 0.80 m. This apparatus is versatile enough to be useful for general research in addition to research on electrostatics in the Martian environment.

range from a minimum of 150 K to a maximum of 473 K. The temperature at 48 different locations within the chamber is monitored by use of thermocouples. Temperature is controlled mainly by balancing (1) the inward leakage of heat from ambient temperature against (2) the removal of heat by circulation of a mixture of warm gaseous nitrogen and cold vaporized liquid nitrogen through a cooling shroud inside the chamber. The rates of flow of the warm and cold nitrogen are monitored by flowmeters and regulated by controllable valves. Additional heating is provided by tape heaters outside the

chamber and additional cooling by a liquid-nitrogen cold plate.

Following initial evacuation, the chamber is backfilled with an atmospheric gas mixture (e.g., CO₂ with small amounts of N₂, Ar, O₂, and H₂O to simulate the Martian atmosphere) at low pressure [typically between 6 and 9 millibars (between 600 and 900 Pa) for the Martian atmosphere]. Thereafter, pressure is brought to and maintained at the required value by use of a feedback control system that balances the rate of flow of atmospheric gas into the system against the rates of leakage and of vac-

uum pumping. The feedback control system includes a pressure sensor and a gas-feed throttle valve.

The composition of the gas is monitored by use of a separately operated residual-gas analyzer, the output of which is sent to the computerized control system. A mass flow controller maintains the desired relative concentrations of the gases in the atmospheric gas mixture.

A programmable logic controller (PLC) is the heart of the computerized control system. The PLC accepts inputs from a manual control panel, capacitance manometers, flowmeters, pressure controllers, and thermocouples. The PLC provides outputs to indicators on the manual control panel, and to the vacuum, heating, cooling, pressure, and gas-composition systems described above. Numerous outputs are sent to a graphical user interface (GUI) that features "soft" controls and indicators that emulate those of the manual control panel with the addition of elaborate graphical management capabilities. The GUI notifies the PLC when it is ready to accept or provide information relative to the control process. Optionally, the operation of the MEC can be controlled by use of the manual control panel alone, or partly by use of the manual control panel and partly by use of the GUI. This option affords flexibility for manually performing tests while maintaining safe operation by use of automatic control.

*This work was done by Carlos Calle and Dean C. Lewis of **Kennedy Space Center**, and Randy K. Buchanan and Aubri Buchanan of VirCon Engineering. For further information, access <http://technology.ksc.nasa.gov/WWWaccess/techreports/2001report/200/207.html>. KSC-12590*

Automated Electrostatics Environmental Chamber

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A solid-phase extraction (SPE) process has been developed for removing alcohols, carboxylic acids, aldehydes, ketones, amines, and other polar organic compounds from water. This process can be either a subprocess of a water-reclamation process or a means of extracting organic compounds from water samples for gas-chromatographic analysis. This SPE process is an attractive alternative to an Environmental Protection Administration liquid-liquid extraction process that generates some pollution and does not

work in a microgravitational environment. In this SPE process, one forces a water sample through a resin bed by use of positive pressure on the upstream side and/or suction on the downstream side, thereby causing organic compounds from the water to be adsorbed onto the resin. If gas-chromatographic analysis is to be done, the resin is dried by use of a suitable gas, then the adsorbed compounds are extracted from the resin by use of a solvent. Unlike the liquid-liquid process, the SPE process works in both

microgravity and Earth gravity. In comparison with the liquid-liquid process, the SPE process is more efficient, extracts a wider range of organic compounds, generates less pollution, and costs less.

*This work was done by Richard Sauer of **Johnson Space Center**, Jeffrey Rutz of Krug Life Sciences, and John Schultz of Wyle Laboratories.*

Inquiries concerning rights for the commercial use of this invention should be addressed to the Patent Counsel, Johnson Space Center, (281) 483-0837. Refer to MSC-22899.